METHOD AND APPARATUS FOR LOCATING THE CENTER OF A CIRCLE

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

[001] The art of locating the center of a circle with a center finder, compass, or hermaphrodite caliper has long been known. The center finder has two surfaces forming an internal angle that is bisected by a straight edge. The circle to be measured is placed against the two surfaces and a line is scribed or drawn on the circle along the straight edge. The center finder is then rotated to a new location on the circumference of the circle. A second line is then drawn on the circle along the straight edge that intersects the first line at the center of the circle. The center finder is effective when measuring the circular end of a cylinder, but less effective for measuring circles drawn on a flat surface.

[002] A compass may be used to find the center of a circle by first adjusting the angle of the compass so that the ends of the compass legs are approximately the radius of the circle. One of the compass legs is placed on the edge of the circle and an arc is drawn or scribed on the circle.

The process is repeated with the leg of the compass positioned at a different location on the circle. If the arcs intersect at more than one point or do not intersect at all, the compass must be readjusted to where the arcs intersect at one point. This single point where the two arcs intersect is the center of the circle.

[003] The use of the hermaphrodite caliper to find the center of a circle is similar to the compass, but is effective for measuring the circular end of a cylinder rather than a circle drawn on a flat surface. The curved end of the hermaphrodite caliper is placed against the edge of the cylinder with the caliper adjusted so the straight end is spaced as close to the center of the circle as possible. An arc is scribed or drawn on the circle by rotating the straight end of the caliper about the end placed against the edge of the cylinder. The caliper is then repositioned with the curved end placed at a different location against the edge of the cylinder and a second arc is scribed or drawn on the circle using the straight end. As with the compass, the caliper must be adjusted so that the two arcs intersect at only one point. This point is the center of the circle.

[004] All of the above devices use the method of drawing or scribing intersecting lines or arcs to locate the center of a circle. There are drawbacks to this current state of the art method:

1. The current method requires multiple step operations. Each device must be placed against the edge of the circle at least twice at different locations in order to generate intersecting lines or arcs.
2. The current method may not be accurate depending on the type of circle being measured. The center finder is prone to errors if used to find the center of a circle drawn on a flat surface due to the difficulty in aligning the surfaces with the edge of the circle. The compass is extremely difficult to use for finding the center of the circular end of a cylinder as the first leg of the compass may tend to slip over the edge of the cylinder as the compass is rotated. The hermaphrodite caliper is prone to errors because the curved end that is placed against the circle edge may slip as the caliper is rotated.

3. The current method requires drawing or scribing lines or arcs on the circle being measured. Should it be objectionable that the circle has extraneous marks, another operation would be required to remove the lines or scribes.

BRIEF SUMMARY OF THE INVENTION

[005] It is therefore the object of this invention to provide a simplified method of locating the center of a circle. It is a further object of this invention to provide a more accurate method of finding the center of a circle whether the circle is drawn on a flat surface or is the circular end of a cylinder. It is yet another object of the invention to provide a method of finding the center of a circle that does not require making marks on the circle being measured in order to find its center.

[006] This invention is a method and apparatus that will locate the center of a circle in a single operation by positioning two points of registration at the edge of the circle relative to a third point of registration previously set at the edge of the circle where these points are held in accurate spatial relationship to each other and a fourth point of registration that in turn, indicates the center of the circle. By allowing precise registration and novel operation, this invention provides a simpler, more accurate means to locate the center of a circle that precludes the need to make extraneous marks on the circle being measured.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a illustrates all of the parts of the preferred embodiment in their assembled configuration;

Figure 1b shows one of the two components of the preferred embodiment;

Figure 1c shows the second of the two components of the preferred embodiment;

Figure 2a illustrates all of the parts of a second embodiment in their assembled configuration;

Figure 2b shows the four components of the second embodiment separated for clarity;

Figure 3 illustrates all of the parts of a third embodiment in their assembled configuration.

DETAILED DESCRIPTION OF THE INVENTION

[007] The novel method consists of setting a first reference point at the edge of the circle to be measured and allowing a single continuous adjustment to be made which aligns at least two other points with the edge of the circle where such adjustment positions another point at the center of the circle by way of a mechanism that maintains accurate spatial relationship of all of the points.

[008] The three mechanical embodiments described below show general types of apparatus that practice the novel method. One skilled in the art will appreciate, that many other configurations of these type apparatus can also practice the invention and still be within the spirit and scope of the claims. It will also be recognized by one skilled in the art that such apparatus may be automated by Electro-mechanical means. Positioning and maintaining the spatial relationship of the points may be performed by a motor or other actuator controlled by a microprocessor. The points that are positioned at the edge of the circle may be photo-detectors or other electronic indicators that provided signals to the microprocessor. The microprocessor would use this information to accurately position the edge locators and center indicator. This automated practice of the invention is also within the spirit and scope of the claims.

[009] Figure 1a shows the preferred exemplary mechanical embodiment of the invention. It is comprised of two general parts, a base member 1, shown by itself in Figure 1b, and an extendable member 2, shown by itself in Figure 1c.

[010] Base member 1 has a pivot post 3 about which it can rotate freely. The pivot post 3 extends through the base member 1 and has an axial hole, is transparent, or has other means that allows the edge of the circle to be seen through the post. The bottom of pivot post 3 may be anti-slip and/or notched for use with a flat circle or end of a cylinder where such a notch is designed to align the edge of the cylinder with the center of the post. The center of the pivot post 3 establishes the first reference point on the edge of the circle to be measured. Base member 1 has a longitudinal cavity 4 running its length with lateral cavities 5 projecting at 60 degrees from either side of it. The lateral cavities are oriented such that the line 6 that bisects the lateral cavities 5 intersects the line 7 that bisects the longitudinal cavity 4 at the center of the pivot post 3 at 60 degrees. The lateral cavities 5 have curved surfaces as they intersect the longitudinal cavity 4 to smoothly redirect the flexible portions of the extendable member 2 as will be described later. The cavities in the base member 1 are sized to accept the extendible member 2 with close but non-interfering tolerance.

[011] The extendible member 2 consists of a center solid longitudinal portion that has a longitudinal slot providing clearance for the pivot post 3 and longitudinal flexible portions 8 on either side. The flexible portions 8 are constructed such that they are normally straight yet can be redirected by the walls of the lateral cavities 5 as they move through them. After being redirected 60 degrees by and exiting from the lateral cavities 5, the flexible portions 8 return to a straight and rigid state. The flexible portions 8 of the extendable member 2 need only be flexible in one degree of freedom in order to be redirected the 60 degrees. Many embodiments of a flexible member with one degree of freedom may be employed such as the use of a tight spring or elastomeric material. An exemplary embodiment shown here is the use of solid segments affixed to the convexing side of a thin flexible material such as spring steel that will bend yet return to straight when the bending force from the walls of the lateral cavities 5 is not in effect. Holes, arrows, or other points of

registration are located at the free end of the flexible portions 8 and are the circle edge locators 9 and 10. The circle edge locator 9 establishes the second reference point on the edge of the circle and edge locator 10 establishes the third. An adjust knob 11 or other means to allow the extendable member to be moved relative to the base member 1 is located at the posterior end of the extendable member 2. A hole, arrow, or other means of registration is located at the anterior end of the extendable member 2, and is the circle center indicator 12. With the circle center indicator 12 being a hole; a pencil, stylus, or other marking device may be inserted to mark just the center of the circle when the pivot post 3 and circle edge locators 9 and 10 are positioned at the edge of the circle.

[012] The operation of this embodiment is as follows:

The pivot post 3 is place at the edge of a flat circle to be measured or against the edge of a cylinder to be measured. The operator may then hold the pivot post 3 in position by pressing it against the circle with a thumb. Using the thumb and forefinger of the other hand, the adjust knob may be pushed or pulled to extend or retract the extendable member 2, as well as rotate the combined base member 1/extendable member 2 assembly. As the extendable member 2 is pushed toward the anterior end of the base member 1, the flexible members are forced outward at 60 degrees by the walls of the lateral cavities 5. The center solid longitudinal portion is extended out of the longitudinal cavity 4 by this same action. The push and/or pull, and rotation is performed until the circle edge locators 9 and 10 are both positioned at the edge of the circle. When this alignment occurs, the circle center indicator 12 is precisely at the center of the circle.

[013] A second embodiment, shown in figure 2a, is another apparatus that implements the present novel method of finding the center of a circle. This embodiment consists of the individual components shown in figure 2b: a base member 13, left rotatable arm 14, right rotatable arm 15, and an extendable member 16.

[014] The base member 13 has a pivot post 17 about which it can rotate freely. The center of the pivot post 17 establishes the first reference point on the edge of the circle to be measured. The base member 13 also has a left rotatable arm pivot post 18 and a right rotatable arm pivot post 19 and extendable member guides 20.

[015] The left rotatable arm 14 has complex curve gear teeth 21 and edge of circle locator 22. The right rotatable arm 15 is a mirror copy of the left rotatable arm 14 and has complex curve gear teeth 23 and edge of circle locator 24.

[016] The extendable member 16 has a longitudinal slot 25 that accommodates the base member pivot post 17, and has a circle center locator 26 located at its anterior end. An adjust knob is located at the anterior end of the extendable member 16. On the left side of the anterior edge of the extendable member 16 is complex curve gear teeth 27. On the right side of the anterior edge of the extendable member 16 is complex curve gear teeth 28.

[017] When assembled as in figure 2a, the rotatable arms 14 and 15 are located on and may rotate about pivot posts 18 and 19 respectively. The extendable member 16 is located between the extendable member guides 20. The extendible member complex curve gear teeth 27 and 28 engage the rotatable arms' complex curve gear teeth 21 and 23 respectively. The shape of the complex curve gear teeth 21 on the left rotatable arm 14 and the shape of the complex curve gear teeth 27 on the right side of the extendable member 16 are complimentary and have a geometry that results in continuous meshing of the gear teeth where the left rotatable arm circle edge locator 22 rotates to the edge of a given circle when the extendible member 16 is moved to where the circle center indicator 26 is at the center of the given circle when the pivot post 17 is also on the edge of the circle. The complex curve gear teeth 28 on the right rotatable arm 15 and the complex

curve gear teeth 28 on the right side of the extendable member 16 mesh in the same fashion. An infinite number of complex curve geometry's will satisfy this relationship and depend on the distance from the center of the rotatable member to the edge locator and the position of the center of the rotatable member relative to the center of the pivot post.

[018] Operation of this apparatus is similar to that of the preferred embodiment. The pivot post 17 is placed on the edge of a circle to be measured. The extendable member 16 is then pushed or pulled and rotated about pivot post 17 until the right and left rotatable circle edge locators, 22 and 24, are positioned at the edge of the circle. When this occurs, the circle center indicator 26 is at the center of the circle.

[019] A third embodiment is yet another apparatus that implements the present novel method of finding the center of a circle. This embodiment, shown in figure 3, consists of a base member 29, a rack and pinion slide 30, racks 31 and 32, pivot post 33, and pinion gear 34. The base member 29 contains a longitudinal slot and a hole that accommodates pivot post 33 about which it may rotate freely. The longitudinal outer surfaces on either side of the slot of the base member 29 are relatively smooth and parallel allowing the rack and pinion slide 30 to move freely in the longitudinal direction. The rack and pinion slide 30 has a hole, post, or other means to accommodate the pinion gear and has groves, rails, or other means to accommodate and hold the racks in proper relationship. The hole, post, or other means of accommodating the pinion gear 34 has a hole in the center, is transparent, or has some other means to indicate or mark the center of the circle and is center indicating point 35. The ends of the racks have holes, are transparent, or have other means to be circle edge locators 36, 37, 38, and 39. These circle edge locators are equidistant from the line that runs through the circle center locator 35 and is perpendicular to the longitudinal direction of the base member 29.